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Scottish farmers' intentions to afforest land in the context of farm diversification

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ABSTRACT

Increasing woodland area in the United Kingdom is strongly supported in policies, but there is evidence of low rates of new planting, infrequent uptake of farm forestry, and negative attitudes to woodland among farmers. Additionally, there is a wider context of increasing farm diversification, and a need for greater understanding of farmers' attitudes and behaviour related to afforestation. This paper uses a representative survey of Scottish farmers (survey year: 2013, respondents used in analysis: 1735) to compare farmers who intended to expand forestry in future and farmers with alternative combinations of intended and past behaviour in relation to forestry. Overall, we find that certain characteristics: already operating forestry, reporting types of non-farming activities, involvement in environmental schemes, having a high education level, having a relatively high number of employees, and being relatively recent entrants to holdings, were more frequently found among farmers intending to increase forestry in future than farmers described as 'non-increasers' who did not intend to increase forestry and also had not expanded it in the past. Farmers with these characteristics could be a useful focus in attempts to expand woodland at larger scales, and encouraging small-scale tree planting could be an effective policy approach.

1. Introduction

UK land represents an important opportunity for increasing the amount of forested area in the EU: forests and woodlands cover only 13% of the UK (Forestry Commission, 2015), in comparison to over 40% of the European Union (EU) (European Commission, 2013). The EU Forest Strategy recognises that sustainable forest management contributes to major societal objectives, including rural economic development and provision of renewable source material (European Commission, 2013); the major role of forests in carbon storage is particularly important due to the EU commitment to a large reduction in greenhouse gas emissions (European Commission, 2016). In this paper we assess the potential of UK farmers to contribute to afforestation targets, based on analysis of past behaviour and stated future intentions.

Strategy and policy documents of national and devolved governments in the UK, and the Irish Government, clearly acknowledge both the diverse positive contributions of forestry, and policies to increase forest area (Scottish Executive, 2006; Scottish Government, 2009; DEFRA, 2013; Department of Agriculture, Food and the Marine (DAFM), 2014). A number of other policies have also supported woodland planting in Scotland and the UK from the 1990s onwards (see Thomas et al., 2015: 151, for summary). In the UK, woodland expansion by farmers and other private landowners has been encouraged by various grant schemes, with over £0.5 billion paid in grants from 2005–6 to 2014–15 within England, Scotland and Wales (see Forestry Commission, 2015: Section 8.6). Aging woodlands in Scotland, with a decreasing ability to sequester carbon, have driven policies favouring woodland expansion (Scottish Government, 2013a). Similar grants and schemes in Ireland boosted private afforestation from the 1980s onwards (DAFM, 2014). Despite this support, recent new planting rates (Forestry Commission, 2015: Table 1.14) are, if maintained, insufficient to meet targets of 10,000 ha per year in Scotland (cited in Scottish Government, 2013a: e.g. 220–1), 5000 ha in England (DEFRA, 2013: 39) and Wales (Osmond and Upton, 2012: 5) and 1000 ha in Northern Ireland (Forest Service, 2014/2015: 5).

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The private sector has been responsible for the vast majority of recent new planting in the UK (Forestry Commission, 2015: Table 1.14) and Ireland (DAFM, 2014: 1)[1]; this is reflective of the EU more broadly, where nearly 60% of forests and woodland were privately owned in 2010 (UK: 66.7%) (Eurostat, 2015a: 143). It has been widely recognised that encouraging woodland planting by farmers and other landowners is critically important for achieving woodland expansion (Scambler, 1989; Ní Dhubháin and Gardiner, 1994; Bull and Thompson, 2011; Wynne-Jones, 2013; Schirmer and Bull, 2014). Indeed, a geographical assessment in Scotland found that the area with most potential for woodland expansion (ca. 2.7 million ha) was dominated by farmland (Sing et al., 2013). However, recent surveys have routinely found very low uptake, or planned uptake, of forestry by farmers. The EU Farm Structure and Methods Survey of 2013 found that 4.3% of holdings (out of 9400) in Scotland reported forestry (Scottish Government, 2013b). The Farm Structure Survey (2010) showed that few holdings operated 'forestry-work' for income generation in the UK (ca. 1.2%: Eurostat, 2015b). In the UK, a strong aversion by the farming community to afforestation has been described in Scotland (Slee et al., 2012; Feliciano et al., 2013, 2014). Furthermore, a survey of ca. 1500 Irish farmers in 2012 found that 10% were considering planting trees using an afforestation scheme, although this increased (to 26%) following the receipt of further information (Duesberg et al., 2014); another Irish survey found that only ca. 6% of 525 farmers without forestry were likely or very likely to consider planting in the near future (Howley et al., 2015).

There are a number of recognised factors influencing afforestation intentions, and similar land-based decisions. A recent review by Dandy (2012) for Forest Research (UK) detailed 27 influences on the decisions of land managers, split into economic, social, physical-environmental and operational categories (Dandy, 2012: 15). Similarly, a recent assessment of Scottish woodland expansion by Thomas et al. (2015) responds to the question "…what factors influence woodland creation on private land(?)" (ibid: 3) using a literature review structured using the theory of planned behaviour (Ajzen, 1991). This framework described intentions to expand woodland as a product of a) external behavioural controls: economic and non-economic incentives (e.g. grants and tax status of woodlands, other positive motivations for tree planting), bureaucracy and advice; b) attitudes and c) social norms (adapted from Thomas et al., 2015: 153–5). In general, two key findings have emerged from social research: a) farmers favouring tree planting on lower quality land, or the presence of low quality land as a positive factor for afforestation (Ní Dhubháin and Gardiner, 1994; Watkins et al., 1996; Wynne-Jones, 2013; Duesberg et al., 2013, 2014; Schirmer and Bull, 2014; Howley et al., 2015) and b) a preference for agricultural production acts as a barrier to tree planting (Watkins et al., 1996; McDonagh et al., 2010; Wynne-Jones, 2013; Duesberg et al., 2013, 2014; Schirmer and Bull, 2014; Howley et al., 2015). In essence, afforestation on farms is framed as counter to the ongoing productivist orientation of farmers: most farmers prefer not to afforest, and if they do afforest, prefer to do so on low quality land.

The resistance to afforestation – as well as persistent productivist orientations – is grounded in long-established cultural norms. Research by Burton (Burton, 2004; Burton et al., 2008) has demonstrated the importance of the 'good farmer' identity, whereby social status is derived from landscape evidence of skilled role performance. In essence, afforestation, and engagement in other environmental activities, not only represents a loss of productive potential of the land (i.e. reduced yields) but also bears a symbolic cost (loss of opportunity to demonstrate farming skill) (Burton, 2004). Farmers resist afforestation on this basis. It is well recognised that farmers are not purely profit-driven (Gasson, 1973; Gasson and Errington, 1993), instead seeking to obtain multiple objectives (such as independence, outdoor work), including achieving the status of 'good farmer'.

Research into the 'good farmer' identity has demonstrated that these socialised norms, while resilient, can change over time. This occurs particularly as farmers come under economic duress (e.g. when high yields are insufficient to achieve profitability – Sutherland, 2013) and engage in new economic fields (which yield different forms of symbolic capital – Sutherland and Darnhofer, 2012). Over the past 20 years, farm diversification has become a prominent topic within broader debates around multifunctional transitions in agriculture (Mather et al., 2006; Maye et al., 2009), reflecting the shift in agricultural policies from a central, common focus on production, towards encouraging a wider set of goods and services to be produced on agricultural land (Sutherland et al., 2016). In Scotland, the number of holdings with 'other gainful activities' increased from 13% (2010) to 21% (2013) (Scottish Government, 2013b). In comparison, 5.2% of the EU's agricultural holdings recorded 'other gainful activities' in 2010, with higher proportions in the UK and Ireland (17.5% and 9.2%, respectively) (Eurostat, 2013: 183). Nijnik et al. (2013) argue that" … carbon sequestration forestry projects are likely to be implemented if they are consistent with the wider programmes of sustainable rural development" (ibid: 41).

This review demonstrates that farmers and land managers have a central role in delivering woodland expansion. Greater knowledge of the drivers of farmer decisions will inform more effective, targeted engagement between national forestry agencies and farmers (Dandy, 2012; Howley et al., 2012). A Scotland-based review by Thomas et al. (2015) notes a continued need for social research into woodland expansion. Schirmer and Bull (2014) describe the high importance of landowner attitudes to tree planting in delivering effective afforestation, and emphasise that these attitudes ('willingness to adopt'), and the factors influencing them, form key research questions. In addition, the interaction of farmer decisions related to woodland expansion, and a broader context of increasing farm diversification, requires careful consideration.

This article utilises a large-scale, representative survey of Scottish farmers to analyse associations between the intentions to expand forestry and characteristics of farmers and their farms, including diversification activities and other farm changes. The emphasis on past behaviour and future intentions is supported by research suggesting that attitudes, and thus up-take, change over time. This study advances the literature in two specific ways: by assessing afforestation within the context of farm diversification, and addressing past behaviour and future intentions to afforest.

The remainder of the paper is organised in five sections. The method (Section 2) and data used (Section 3) are described, before the results of the statistical analysis are detailed (Section 4) and discussed (Section 5), followed by a conclusion which includes policy recommendations (Section 6).

2. Method

This paper is based on a telephone survey of Scottish holdings (2013), which collected detailed information on past and planned farm changes (total responses = 2416). More detailed information on the data collection and sample are described within the 'Data' section. Farmer intentions regarding afforestation were assessed based on two survey questions: respondents were asked whether they had changed the area of forestry since 2005, with responses of 'Decrease', 'No change', 'Increase' or 'not applicable'. A similar question was asked for intentions to change the area of forestry by 2020. A variable was created from these responses: where a farmer had answered both questions (i.e. 'Decrease', 'No change' or 'Increase') they were classified into one of three groups:

- Farmers who intended to increase the area of forestry by 2020, irrespective of past changes made ($n = 200$)
- Farmers who did not intend to increase the area of forestry by 2020,

[1] Howley et al. (2012: 33–4) also provides an overview of Irish afforestation.

and who also had not increased forestry since 2005 ($n = 1385$)
- Farmers who did not intend to increase the area of forestry by 2020, but who had increased forestry since 2005 ($n = 150$).

Cases where one or both questions were not answered ($n = 681$) were not included in the analysis. For clarity, the three groups are referred to as 'future increasers', 'non-increasers' and 'past increasers', respectively. The non-increasers group captures elements of a) traditional aversion to forestry among farmers (e.g. Slee et al., 2012) and b) low present uptake of farm forestry (see Introduction). The future increasers and non-increasers groups show sharply contrasting attitudes to woodland expansion, and provide the key comparison relevant to future woodland expansion. The remaining respondents, defined as past increasers, had expanded forestry in the past, but were unlikely to contribute to future woodland expansion.

The variable signifying intentions of respondents to increase forestry area (described above) was included in the analysis with 51 other variables (48 = categorical). The selected variables reflect influences (and categories of influences) on landowner decisions included in the framework of Dandy (2012, see Introduction for summary). This recent and comprehensive framework was developed in order to help a public forestry body to improve landowner engagement, as a necessary means to the ends of successful woodland expansion and improved management (Dandy, 2012: 3); a context which is most relevant to the objectives of this study. Additionally, the variables included for analysis reflect factors included in other frameworks of decision making and some more specific literature gaps. The analysis variables were grouped into four 'classes'.

Firstly, farmer characteristics: nine variables, including descriptors such as gender, age group, education and 'status' or ownership of land. These characteristics may affect the "…capacity of managers to be able to assess the resource they have" (Dandy, 2012: 48) and are noted as an influence on farmers' ability to participate in policy measures (Siebert et al., 2006: 328–9). In addition, 'socio-demographic' factors have been included within contemporary analyses of farm afforestation behaviour (Duesberg et al., 2014; Howley et al., 2015).

Secondly, farm characteristics and perceived economic prospects: eight variables, incorporating farm type and area, employment levels and perceptions related to income sources and economic status. Dandy (2012) describes a number of 'Physical-Environmental' influences on decision-making, including "…concerns about productivity, location, climate and environmental quality" of the land (Dandy, 2012: 41). In addition, farm employment forms a potential proxy for labour availability (see Dandy, 2012: 50) and income sources and economic perceptions link to economic influences (Dandy, 2012: 18–28). Siebert et al. (2006) also note farm characteristics as related to ability to participate (ibid: 328–9), and 'structural' factors included in recent studies (Duesberg et al., 2014; Howley et al., 2015) correlate with some variables included here.

Thirdly, farmer perceptions and attitudes: eight variables, including farmer attitudes related to their identity and social norms, business and environmental management, and perceived difficulty of changing the area of forestry. The importance of the social context and farmers' beliefs on decision-making is very clear from the literature summarised in the Introduction: social influences are subdivided by Dandy (2012) into three areas, two of which are 'Community and Society' and 'Personal Interests & Values', the latter including the influence of existing farmer objectives (Dandy, 2012: 33–41). The variables covered in this research include attitudes to statements related to the 'good farmer' identity and achieving high output from resources (see Burton, 2004) and environmental management.

Fourth, farm diversification and innovation uptake: variables related to diversification activities, participation in organic farming and environmental schemes, increasing farm activities since 2005, technological innovations. This variable class includes 26 variables, including uptake of specific types of diversification and forestry itself. The rationale for including farm diversification is described above: however, it is notable that "...the influence of existing woodland ownership" has been raised as a specific subject where knowledge should be improved (Thomas et al., 2015: 156); additionally, a recent study in Ireland suggests a positive effect of past planting on intended planting (Duesberg et al., 2014). With respect to diversification, there are also links between the four variable categories described here, and the types of explanatory variables (socio-demographic, economic and geophysical characteristics) used to study farm diversification activities (Meraner et al., 2015: 771–2).

The supplementary material shows the questions from the telephone survey and the derived variables used within the analysis.

3. Data

In order to carry out the telephone survey, information from the Scottish June Agricultural Census (JAC) was used to define a spatially representative sample of 10,000 farm holdings (see Barnes et al. (2016) and Sutherland et al. (2016) for other research based on this dataset, and for details of the survey), this generated 2416 responses. Based on indicated forestry changes (see Method), 1735 respondents were included in the analysis.

Some information on farm characteristics was taken from JAC (2013) data tables: Less Favoured Area (LFA) status of holdings (see Scottish Government Directorate for Environment and Forestry, Rural and Environment Science and Analytical Services (SGDEF and RESAS), 2014: 6), farm type (see SGDEF and RESAS, 2014: 12–13 for categories), and farm area. These were merged with the survey data based on 'holding code' – an identifier for agricultural holdings in Scotland. LFA status and farm type were available for all except 19 cases, farm area was merged for all but 18 respondents.

The characteristics of farmers within the overall sample of 1735 respondents were broadly representative of Scottish farmers in terms of age and gender balance, and the level of uptake of most farm diversification activities (Table 1), although full-time farmers and holdings with employees were over-represented in comparison with Scotland. This reflects the data collection method, which was stratified on the basis of farm type, thus smaller holdings were under-represented (see Sutherland et al., 2016: 14). Furthermore, it can be expected that full-time farmers are more likely to be present on farm than part-time farmers. However, owing to the sample size, we are confident that the survey has captured the majority of producer intentions.

Data analysis used the bivariate Chi square and Kruskal-Wallis tests. The former (most frequently used) was used to test whether two categorical variables are significantly associated (Pallant, 2013: 225–9), and the latter assessed whether measures or quantities were significantly different across the farmer groups (Pallant, 2013: 240–3). Where Chi square test assumptions (of sufficient expected cell counts) were not met (see Freeman and Julious, 2007) Fisher's exact test[2] was used.

For statistically significant test results (where $p < 0.05$), this paper cites effect sizes: Cramer's V (ϕ_C) for Chi square tests, and r. The latter was used where a Kruskal-Wallis test result was significant; in these cases, the Mann-Whitney U test was calculated to assess whether differences between pairs of farmer groups were significant (Pallant, 2013: 235–8), and the method for the calculation of r is noted in Field et al. (2012: 664–6[3]) and Pallant (2013: 238). These effect sizes are comparable measures of association strength (Ferguson, 2009). Field et al. (2012: 666) use Cohen's (1992: 157) guidance to interpret r when derived from the p-value of the Mann-Whitney U test. Pallant (2013: 228) provides thresholds for Cramer's V for different table dimensions. Ferguson's (2009) guidance for social science data suggests that for r

[2] See https://stat.ethz.ch/R-manual/R-devel/library/stats/html/fisher.test.html. Where used, p values were computed by Monte Carlo simulation, 2000 replicates.
[3] Field et al. (2012) note that the equation source is Rosenthal (1991: 19).

Table 1
Comparison of characteristics of farmers within the sample of farmers analysed within this paper, and Scottish farmers as a whole. All figures show percentages.

	Scottish farmer sample, 2013 (n = 1735)	All farmers in Scotland (data source indicated)
Age		
54 or under	45.8	43.9
55–64	29.9	26.3
over 65	24.3	29.8
		June 2013, based on working occupiers. JAC data uses an 'over 64' category (SGDEF and RESAS, 2014: 143 (table C20))
Gender		
male	81.9	85.6
		June 2015, based on working occupiers with both age and gender data (Scottish Government, 2015: 58 (table 8c))
Status		
full-time	64.8[a]	35.3
		June 2013 data, based on all working occupiers (SGDEF and RESAS, 2014: 144–145 (table C21(i)))
Employment		
0	49.7	88.0
1–3	42.5	10.6
4 or more	7.8	1.3
		June 2013, figures refer to numbers of holdings as a percentage of 52,716 total holdings in Scotland, figures also relate to full-time employees only. (SGDEF and RESAS, 2014: 148 (table C22), and 127 (table C1) for holding count)
Diversification		
processing of farm products	2.1	1.0
tourism	9.2	8.6
renewable energy	8.2	2.7
agricultural services	2.6	5.2
forestry	5.4	4.3
		Figures from Scottish Government (2013b: 17). Note that wordings of the non-farming enterprises on the farmer survey form and the names of the 'other gainful activities' in the EU survey differ slightly

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[a] Based on 1719 farmers, due to "not applicable" responses.

and ϕ_C a value of 0.2 represents practical significance, with values of 0.5 and 0.8 for moderate and strong effects (Ferguson, 2009: 533).

Data handling, analysis and graphing used R (R Core Team, 2015a, 2016) including functions from the packages 'foreign' (R Core Team, 2015b) and 'lsr' (Navarro, 2015).

4. Results

The analysis is described in four sections below, which correspond to the variable classifications.

4.1. Farmer characteristics

For respondent characteristics, four significant associations were found with woodland expansion intention (Table 2). The strongest association found was with education level. Evidence suggested that future increasers (FI) were, as a group, better educated than non-increasers (NI) or past increasers (PI). Just over a third (36%) of future increasers had a university level education, compared with 18% of non-increasers and 31% of past increasers; furthermore, the proportion of future increasers with only a school level education (28%) was smaller than the respective figure of past increasers (33%) and far lower than that of non-increasers (49%). Length of involvement in the farm business/holding was also significantly associated with woodland expansion intention. Majorities of all three groups had been involved more than 20 years, but future increasers were somewhat more likely than non-increasers to be relatively recently involved. 12% of future increasers had less than five years' association with the business/holding, and 10% had been involved for five to ten years: respective figures for non-increasers were 5% and 6% (and 7% and 11% for the past increasers). Similarly, there was a significant association between age and intentions to expand woodland, with responses showing that future increasers were more likely to be relatively young (below 45 years of age) than farmers in the other groups. Finally, ownership status was significantly associated with woodland expansion intention, although the association pattern is less clear: past increases were least likely, of all three groups, to be tenants (12% were tenants).

Other key farmer descriptors were not significantly associated with forest expansion intention. The distribution of responses shows that, in all three groups, around eight out of ten farmers were male, six out of ten (or slightly more) were full time farmers, ca. six out of ten had inherited the business or holding from a previous generation, over nine in ten intended to continue farming in the near future and around half had identified a successor.

4.2. Farm characteristics and perceived economic prospects

Analysis of farm characteristics (Table 3) found that the number of people employed was significantly associated with woodland expansion intention. Respondents planning to increase forestry were more likely to be related to holdings employing relatively high numbers of people, in comparison with other farmer groups: 17% of future increasers were on farms which employed four or more people (NI: 7%, PI: 4%). Regarding the farm land itself, a significant difference in farm area was found: past increasers had far larger farms, on average, than those in other groups. As may be expected, farms with high numbers of employees (four or more) were larger, on average, than holdings with no or few (one to three) employees. The median area of a holding with no employees was 68.94 ha ($n = 855$), compared with 136.37 ha ($n = 728$) for a holding with one to three employees and 205.54 ha ($n = 135$) for farms employing four or more staff (Kruskal-Wallis test: $\chi^2(2,1718) = 171.722$, $p = 0$). Farm area was significantly different between the non-increasers and past increasers ($W = 81800$, $p = 0$, $r = -0.103$), but area was not significantly different between future increasers and either of the other groups (FI/NI: $W = 143680$, $p = 0.182$; FI/PI: $W = 12978$, $p = 0.055$). LFA status was significantly but weakly associated with intention to expand forestry: future increasers were marginally more likely to be associated with LFA holdings than other groups. No significant association was found with farm type: just over half of respondents in each of the three groups were associated with 'LFA Cattle & Sheep' holdings.

Analysis of income-related variables found that subsidy dependence was not significantly associated with woodland expansion intention. However, the proportion of holding income derived from agriculture, perceptions of the current economic position of the household and future economic prospects were significantly associated with intention to expand forestry, but these were very weak associations ($\phi_C < 0.1$). Future increasers were less likely to be highly dependent on agriculture for income than other farmers (proportion of respondents receiving more than three quarters of their income from agriculture on the farm – FI: 39%, NI: 50%, PI: 47%). Additionally, future increasers and past increasers were more likely to have a positive view of the household's economic prospects (FI: 53%, PI: 51%, NI: 40%); this pattern is also found in the assessment of current economic situation, though with a smaller difference between in the respective 'positive' values.

Table 2
Farmer characteristics: responses summary for future increasers (FI), non-increasers (NI) and past increasers (PI), showing statistical test results.

Variable	Response	FI (%)	NI (%)	PI (%)	p	Test (notes)
Gender	female	20.0	18.0	16.7	0.702ns	$\chi^2(2,1735) = 0.709$
	male	80.0	82.0	83.3		
Age	<35	9.5	5.0	8.0	**0.004****	$\chi^2(8,1735) = 22.278$ $\phi_C = 0.080$
	36–44	16.0	9.5	12.0		
	45–54	24.0	30.0	33.3		
	55–64	30.5	30.1	27.3		
	over 65	20.0	25.5	19.3		
Education level	school	27.5	48.6	32.7	**0****	$\chi^2(4,1735) = 57.042$ $\phi_C = 0.128$
	college	36.5	33.2	36.0		
	university or higher	36.0	18.2	31.3		
Status to land	owner or manager	70.5	65.3	74.0	**0.037***	$\chi^2(4,1735) = 10.190$ $\phi_C = 0.054$
	tenant	16.5	21.8	12.0		
	tenant and owner	13.0	12.9	14.0		
Years involved in business/holding	less than 5 years	11.5	4.6	6.7	**0****	$\chi^2(6,1735) = 31.867$ $\phi_C = 0.096$
	around 5 to 10 years	9.5	5.6	11.3		
	around 10 to 20 years	16.5	14.7	18.0		
	more than 20 years	62.5	75.1	64.0		
Description of role	full time farmer	59.6	65.1	69.1	0.460ns	$\chi^2(6,1719) = 5.678$
	part time farmer	24.2	21.9	16.8		
	hobby farmer	8.1	7.3	8.7		
	manager or Business person	8.1	5.8	5.4		
Business/holding inherited	yes	60.5	66.6	60.0	0.082ns	$\chi^2(2,1735) = 4.996$ (other = 'no')
Plans to farm to 2020	yes	96.0	92.1	93.3	0.129ns	$\chi^2(2,1735) = 4.096$ (other = 'no')
Identified successor	yes	51.5	47.7	49.3	0.573ns	$\chi^2(2,1735) = 1.114$ (other = 'no or too early')

Notes (for this table and Tables 3, 4 and 5): figures for the three groups of farmers show the percentage of respondents giving that response (or combination of responses, depending on recoding), except where values are medians. All response categories are shown, except for variables with two responses where only the "yes", "increase" or "agree" responses are shown (see 'Test (notes)' column). The chi square test was used except where indicated, with test details and Cramer's V values summarised within the 'Test (notes)' column: Cramer's V only calculated for statistically significant associations. p values are shown in a separate column: bold 'p' values flagged '*': significant at the 95% confidence level, '**': significant at the 99% confidence level, 'ns': not significant. Percentages are given to one decimal place, other values are given to three. Where p = 0, values are below 0.0005.

4.3. Farmer perceptions and attitudes

Analysis of farmer perceptions and attitudes (Table 4) found few variables to be significantly related to woodland expansion intention. Within the three groups, all or almost all farmers agreed that they strove to be a good farmer, just below a quarter of respondents agreed that it was not important to be viewed as a good farmer, and attitudes to land condition and farmers' role in emissions reduction were also similar across the groups: none of these variables were significantly associated with intention to expand woodland. However, two significant associations with attitudes were found, although these were very weak ($\phi_C = 0.075, 0.088$). Non-increasers were slightly more likely than respondents in other groups to agree that they aimed for the highest output from their resources (89% did, compared with 84% and 82%), and non-increasers were also more likely (by a small margin) to agree that "My main concern is to provide a comfortable lifestyle for my family" (93% agreed, compared with 86% and 87%).

However, it is particularly notable that perceived difficulty of changing the area of forestry significantly differed across the farmer groups. Future increasers perceived changing forestry to be more difficult on average, than farmers in the non-increasers and past increasers groups did (median difficulty rating on a scale of 1 (easy) to 5 (difficult) – FI: 3, NI: 1, PI: 2). There was a significant, moderate difference in perceived difficulty of changing forestry between future increasers and non-increasers ($W = 217390, p = 0, r = -0.364$), and differences in perceived difficulty between other groups were also significant (NI/PI: $W = 75879, p = 0, r = -0.146$; FI/PI: $W = 20631, p = 0, r = -0.330$). This pattern across the three groups may represent actual experience with forestry by future increasers (and past increasers), however it also suggests that this perceived difficulty is not a barrier to intending to increase the area of woodland.

4.4. Farm diversification and innovation uptake

Several variables describing currently operated non-farm enterprises and farm changes were significantly associated with intentions to expand forestry (Table 5). The test results show a consistent picture: farmers intending to increase forestry area were more diversified and active in management, in comparison to non-increasers. In comparison to these groups, past increasers' behaviour was more variable. Graphical summaries of group differences (Figs. 1, 2) accompany the description below.

In relation to non-farm enterprises, by far the strongest association found was with operating forestry itself. Future increasers were more than six times as likely to already have forestry on farm than non-increasers; past increasers were also more likely to have forestry than non-increasers (had forestry – FI: 18%, NI: 3%, PI: 13%). Further analysis of statistically significant associations (described in Table 5) shows that, compared with the non-increasers, the future increasers were:

- slightly less than three times as likely to be operating tourism and/or other recreational activities on the farm; the proportion of past increasers operating the enterprise was between the future increasers and non-increasers percentages
- more than five times as likely to process or sell farm produce; the respective figure for past increasers again lay 'in between'
- more than twice as likely to be involved in renewable energy.

Additionally, farmer intentions to expand forestry were significantly associated with participation in environmental schemes. At the time of

Table 3
Farm characteristics: responses summary and statistical test results.

Variable	Response	FI (%)	NI (%)	PI (%)	p	Test (notes)
Level of employment	none	44.0	51.4	41.3	**0****	$\chi^2(4,1735) = 35.956$ $\phi_C = 0.102$
	one to three	39.0	41.7	54.7		
	more than four	17.0	6.9	4.0		
Proportion of income from agriculture on farm	zero	5.0	7.7	9.3	**0.001****	$\chi^2(8,1735) = 27.518$ $\phi_C = 0.089$
	less than 25 %	19.0	12.4	10.7		
	around 25-50 %	20.0	15.6	9.3		
	around 50-75 %	17.5	14.4	23.3		
	over 75 %	38.5	49.9	47.3		
Proportion of income from subsidies	zero	17.0	14.2	14.0	0.589ns	$\chi^2(4,1735) = 2.818$
	less than half	49.5	48.7	53.3		
	half or more	33.5	37.1	32.7		
Perceived current economic position of household	positive	38.5	33.5	41.3	**0.024***	$\chi^2(4,1735) = 11.194$ $\phi_C = 0.057$
	fair	48.0	54.2	41.3		
	negative	13.5	12.3	17.3		
Perceived economic prospects for household	positive	52.5	40.0	51.3	**0****	$\chi^2(4,1735) = 20.920$ $\phi_C = 0.078$
	fair	40.0	49.7	35.3		
	negative	7.5	10.3	13.3		
Less Favoured Area status of holding	LFA	84.3	75.6	71.8	**0.011***	$\chi^2(2,1717) = 9.092$ $\phi_C = 0.073$
	Non-LFA	15.7	24.4	28.2		
Farm type	General cropping	1.5	3.9	7.4	0.118ns	Fisher's Exact Test n = 1717
	General cropping; forage	12.1	10.6	8.1		
	LFA Cattle & Sheep	58.1	58.2	55.0		
	Mixed holdings	11.6	10.7	12.1		
	Non-LFA Cattle & Sheep	2.0	2.2	2.0		
	Specialist cereals	4.0	5.9	8.1		
	Specialist dairy	4.0	5.2	4.0		
	Specialist horticulture & permanent crops	3.0	0.9	0.7		
	Specialist pigs	2.0	0.7	0.7		
	Specialist poultry	0.0	1.2	1.3		
	unclassified	1.5	0.5	0.7		
Farm area (hectares)	median	114.5	99.4	171.0	**0****	$\chi^2(2, 1718) = 16.488$ Kruskal-Wallis Test

Description of table content: see notes for Table 2.

the survey, 61% of future increasers had participated in an environmental scheme, and 75% were participating or planned to remain or become involved in one in future; respective figures for non-increasers were much lower (38%, 51%) although, of all three groups, past increasers were most likely to be involved in these schemes (67%, 75%). Finally, future increasers were nearly three times as likely to be certified organic (or be within a conversion period) in comparison to non-increasers (FI: 12%, NI: 4%, PI: 11%).

Clearly, farm diversification activities were not frequently undertaken by survey respondents, although participation in environmental schemes was reported more frequently. However, as a whole, farmers intending to increase forestry show greater farm diversification and

Table 4
Farmer perceptions and attitudes: responses summary and statistical test results.

Variable	Response	FI (%)	NI (%)	PI (%)	p	Test (notes)
Strives to be a good farmer	agree	100.0	98.8	99.3	0.380ns	Fisher's Exact Test n = 1677 (other = 'disagree')
Not important to be viewed as a good farmer	agree	20.7	23.8	22.0	0.599ns	$\chi^2(2,1591) = 1.024$ (other = 'disagree')
Aims to have highest output from resources	agree	84.2	89.1	81.7	**0.011***	$\chi^2(2,1616) = 9.107$ $\phi_C = 0.075$ (other = 'disagree')
Main concern: family is comfortable	agree	86.5	92.8	87.1	**0.002****	$\chi^2(2,1598) = 12.258$ $\phi_C = 0.088$ (other = 'disagree')
Important to leave land in good condition	agree	99.0	98.9	99.3	1ns	Fisher's Exact Test n = 1696 (other = 'disagree')
Land condition improved since 2005	agree	88.8	84.0	90.2	0.056ns	$\chi^2(2,1458) = 5.767$ (other = 'disagree')
Farmers should adapt to reduce emissions	agree	72.9	71.8	64.8	0.231ns	$\chi^2(2,1390) = 2.928$ (other = 'disagree')
Perceived difficulty of changing forestry area	median	3	1	2	**0****	$\chi^2(2,1717) = 222.927$ Kruskal-Wallis Test

Description of table content: see notes for Table 2.

Table 5
Farmer behaviour and decision making: responses summary and statistical test results.

Variable	Response	FI (%)	NI (%)	PI (%)	p	Test (notes)
Profit orientation	yes	81.5	84.4	84.7	0.565ns	$\chi^2(2,1735) = 1.142$ (other = 'no')
Operates processing/retail of farm produce	Yes	6.5	1.2	4.0	**0****	Fisher's Exact Test n = 1735 (other = 'no')
Operates tourism/recreation	Yes	20.5	7.0	14.0	**0****	$\chi^2(2,1735) = 42.854$ $\phi_C = 0.157$ (other = 'no')
Operates forestry	Yes	18.0	2.8	12.7	**0****	$\chi^2(2,1735) = 95.467$ $\phi_C = 0.235$ (other = 'no')
Operates agricultural services	Yes	5.0	2.2	2.7	0.071ns	$\chi^2(2,1735) = 5.280$ (other = 'no')
Operates renewable energy	Yes	15.0	6.9	11.3	**0****	$\chi^2(2,1735) = 17.119$ $\phi_C = 0.099$ (other = 'no')
Operates equine services	Yes	2.5	2.5	2.7	0.994ns	$\chi^2(2,1735) = 0.012$ (other = 'no')
Participation in environmental scheme	yes	61.0	38.3	67.3	**0****	$\chi^2(2,1735) = 74.612$ $\phi_C = 0.207$ (other = 'no')
Participation/planned participation in environmental scheme	yes	75.0	50.8	75.3	**0****	$\chi^2(2,1735) = 67.325$ $\phi_C = 0.197$ (other = 'no')
Organic certification	yes or in conversion period	12.0	4.1	10.7	**0****	$\chi^2(2,1735) = 28.598$ $\phi_C = 0.128$ (other = 'no')
Changed commodities produced	yes	15.0	12.6	22.7	**0.003****	$\chi^2(2,1735) = 11.752$ $\phi_C = 0.082$ (other = 'no')
Increased business/holding size	increase	30.5	25.9	38.7	**0.002****	$\chi^2(2,1735) = 12.001$ $\phi_C = 0.083$ (other = 'no')
Increased production intensity	increase	33.7	26.5	36.2	**0.008****	$\chi^2(2,1721) = 9.743$ $\phi_C = 0.075$ (other = 'no')
Increased number of livestock	increase	41.3	35.5	53.8	**0****	$\chi^2(2,1380) = 16.347$ $\phi_C = 0.109$ (other = 'no')
Increased employed labour	increase	11.0	10.4	24.8	**0****	$\chi^2(2,1594) = 24.387$ $\phi_C = 0.124$ (other = 'no')
Increased diversification	increase	31.1	17.3	37.4	**0****	$\chi^2(2,1605) = 43.484$ $\phi_C = 0.165$ (other = 'no')
Increased land rented/contracted out	increase	22.0	13.6	22.2	**0.001****	$\chi^2(2,1575) = 13.355$ $\phi_C = 0.092$ (other = 'no')
Increased family labour	increase	18.2	12.8	27.0	**0****	$\chi^2(2,1688) = 22.595$ $\phi_C = 0.116$ (other = 'no')
Increased renewable energy production	increase	37.3	18.0	39.8	**0****	$\chi^2(2,1470) = 55.286$ $\phi_C = 0.194$ (other = 'no')
Increased investment in tourism/recreation	increase	32.7	7.0	23.2	**0****	$\chi^2(2,1439) = 114.140$ $\phi_C = 0.282$ (other = 'no')
Increased animal welfare	increase	46.1	37.0	47.9	**0.010***	$\chi^2(2,1378) = 9.208$ $\phi_C = 0.082$ (other = 'no')
Increased investment in new technologies	increase	51.0	35.3	50.0	**0****	$\chi^2(2,1705) = 26.811$ $\phi_C = 0.125$ (other = 'no')
Increased off-farm investment/activity	increase	32.6	13.3	31.6	**0****	$\chi^2(2,1638) = 64.545$ $\phi_C = 0.199$ (other = 'no')
Increased agri-environmental activity	increase	33.2	9.7	44.6	**0****	$\chi^2(2,1710) = 177.697$ $\phi_C = 0.322$ (other = 'no')
Had applied any technological innovation since 2005	yes	40.6	29.6	41.2	**0****	$\chi^2(2,1720) = 16.149$ $\phi_C = 0.097$ (other = 'no')
Percentage of applicable farm activities increased since 2005	median	30.8	15.4	33.3	**0****	$\chi^2(2,1735) = 126.131$ Kruskal-Wallis Test

Description of table content: see notes for Table 2.

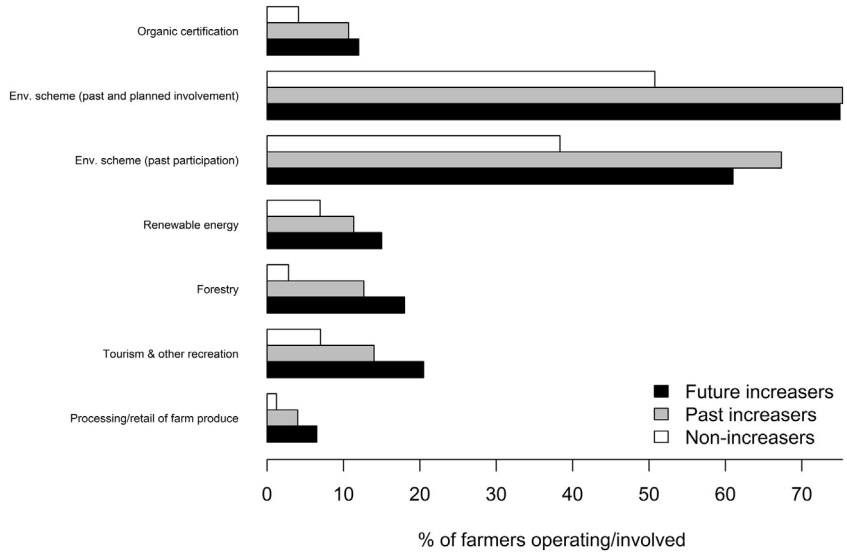

Fig. 1. Comparison of the uptake of non-farming enterprises and environmental schemes by the farmer cohorts. Only the variables with significant test results are shown.

experience of environmental schemes than the non-increasers; particularly those already operating forestry and processing and retail of farm produce. There are large differences in activity uptake between future increasers and non-increasers (based on the advice of Ferguson (2009: 533) for interpreting relative risk). The differences between the two farmer cohorts for other enterprises (tourism and recreation, operating renewable energy, organic status) were above practical significance (ibid.).

A comparison of the direction of a set of farm activity changes made in the years prior to the survey again shows a consistent pattern for future increasers and non-increasers, though with more variable results for past increasers (Table 5, Fig. 2). These recent farm changes capture a different dimension to the uptake of non-farm enterprises described above, providing indicators of recent trends in farm activity and management: to emphasise this, 212 respondents operated a type of non-farm enterprise, and stated that they had increased diversification in recent years. However, another 280 respondents who operated a non-farm enterprise had not increased (that is, not changed or decreased) diversification in the years prior to the survey. Overall, future increasers were more likely to be active in farm management (that is, increasing elements of production, investment and farm activities, rather than not changing or reducing their level) in comparison with farmers with no intention of increasing forestry (Table 5, Fig. 2). A measure of overall activity in farm management: the percentage of applicable activities which had been increased since 2005, was calculated for each survey respondent. Average activity rates were highest among past increasers (median: 33% applicable activities increased), with a similar average rate for future increasers (31%), however non-increasers were far less active (15%). There was a significant difference in overall recent farm activity across the three farmer groups (Table 5), and post-hoc tests found significant differences in activity rate between future increasers and non-increasers ($W = 183710$, $p = 0$, $r = -0.189$) and between past increasers and non-increasers ($W = 57204$, $p = 0$, $r = -0.233$). However, there was no significant difference between future increasers and past increasers ($W = 13182$, $p = 0.052$). Finally, a significant association was found between innovation uptake (having applied or started to apply any of the given technological innovations) and woodland expansion intention. Future increasers and past increasers were more

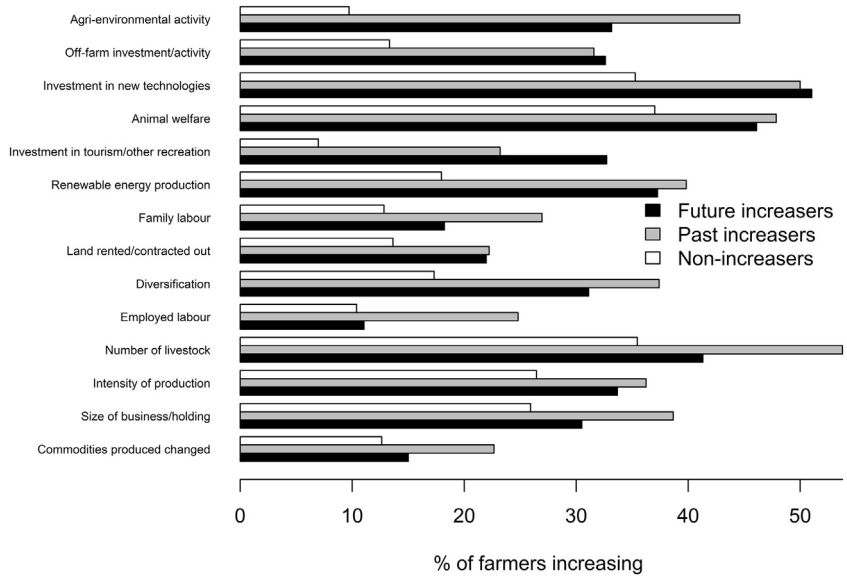

Fig. 2. Comparison of past farm changes made by the farmer cohorts. Variables with significant test results are shown.

likely than non-increasers to have applied a technological innovation since 2005 (FI: 41% had, NI: 30%, PI: 41%).

5. Discussion

In this paper we have identified statistically significant differences between groups of farmers, based on intended changes to forestry area, in a representative survey of Scottish farmers. The observation that farmers in the non-increasers group outnumbered those defined as future increasers by more than six to one, is consistent with the known low uptake of farm forestry across the UK and Ireland (Section 1), and the low interest in new tree planting among farmers observed in recent research (e.g. Howley et al., 2015). This correlates with the conservative attitudes of farmers towards planting bioenergy crops and a 'follow the leader' approach to farm change (Convery et al., 2012), and a low likelihood of farmers considering activities not used in the past (Feliciano et al., 2014).

In terms of farmer characteristics, education level and age (and time involved in the business or holding) were significantly associated with intentions to expand forestry. Our findings thus support research demonstrating that younger farmers are more likely to engage in woodland planting (Howley et al., 2012) and farm diversification more broadly (Meraner et al., 2015, Khanal and Mishra, 2015). The delay in receiving income from tree planting has been cited as a key factor relevant to older farmers (Scambler, 1989; Watkins et al., 1996). Schirmer and Bull's (2014) analysis of overall 'willingness to adopt' afforestation for carbon sequestration, and willingness to engage in tree planting in three geographical 'scenarios' found that the period of property ownership was significantly, negatively correlated with willingness to adopt all four types of forestry, and that age was significantly (negatively) correlated with overall willingness. Although some studies of farm woodland planting have found no significant effect of education on afforestation intention (Ní Dhubháin and Gardiner, 1994) or willingness to adopt tree planting (Schirmer and Bull, 2014), Duesberg et al. (2014) found a significant association between education and farmers' reasons for not planting trees.

This study has found that intentions to expand woodland were also associated with labour ('future increasers' were most likely to have four or more employees), and future increasers were less likely to be highly dependent on agricultural income than other groups. These factors represent examples of operational and economic influences on decisions (Dandy, 2012), and the number of family workers has been found to have a positive effect on farm diversification (Khanal and Mishra, 2015; Meraner et al., 2015). However, our analysis found non-significant results for farm characteristics such as approximate subsidy income and farm type. Less Favoured Area status was only weakly associated with woodland expansion intention, and farm area did not significantly differ between future increasers and non-increasers. These results appear surprising given the documented significant effects of farm type and land quality on forestry uptake (Howley et al., 2015), and farm type on diversification (Khanal and Mishra, 2015) as well as the influence of farm area (Ní Dhubháin and Gardiner, 1994; Crabtree et al., 2001; Duesberg et al., 2014) and that of poor quality land availability on tree planting (see Introduction).

Most notably, evidence of farm activity and farm diversification – operating non-farm enterprises, especially forestry itself, appeared as a strong influence on intentions to increase woodland. The finding that future forest increasers were more than six times as likely to already have forestry (compared with non-increasers) supports the view of Thomas et al. (2015) that social norms and the effect of current woodland are priorities in woodland expansion research. The positive effect of current farm woodland on intentions for tree planting has been noted (Ní Dhubháin and Gardiner, 1994; Duesberg et al., 2014); Crabtree et al. (2001) found that that farmers participating in a farm woodland grant scheme had more extensive woodland (relative to farm size), on average, than 'non-entrants'; inexperience was also cited as a barrier to participation. Schirmer and Bull (2014) found that afforestation's effects were more likely to be viewed positively, and 'willingness to adopt' planting was greater, if farmers felt that it was perceived positively within local communities; Scambler (1989) suggested that personal experience or knowing those interested in forestry may influence attitudes. Therefore, we can suggest two key questions for continued research. Firstly, what is the extent of new tree planting that can be achieved by farmers who already have woodland? And secondly, if very low numbers of farmers are intending to increase forestry, but it is possible that they might do so to follow the actions of others (Watkins et al., 1996; Convery et al., 2012), how could a boost in the numbers of farmers intending to plant forestry for the first time be achieved?

Taking a broader view of the results, a limitation of the study is the over-sampling of full-time farmers and farmers with employees. Additionally, while the survey identified the intended 'direction' of change in farm forestry, it did not collect data on actual areas of afforestation or deforestation, or the reasons for past and intended woodland changes. However, the strongest associations, and larger differences in group responses found in this study arguably form 'sign posts': identifying characteristics of farmers more willing to engage in woodland expansion (Race and Curtis, 2007: 172) which offer highly useful information to government departments and public bodies involved in forestry policy. Farmers intending to expand woodland were more likely to have certain characteristics: already operating forestry, reporting types of diversification, being involved in environmental schemes, being better educated, employing higher numbers of people, and being involved in the farm for a relatively short time than 'non-increasers'. As such, EU supports for new entrants, diversification and environmental scheme participation may indirectly encourage afforestation. New entrants to farming are widely recognised as important to the ongoing vitality and competitiveness of European agriculture, bringing with them innovative approaches and high levels of entrepreneurship (EIP-AGRI Focus Group, 2016). Furthermore, it has been noted that "…new entrepreneurial farmers" could be more open to afforestation than established farmers (Slee et al., 2012: 288) and Convery et al. (2012: 298) suggest that tree planting could occur (partly) due to an increasing population of "…non-traditional owners". Farmers intending to expand woodland were also more likely than non-increasers to be less dependent on agriculture for income and be active in general; in particular, increasing investment in tourism or other recreation and increasing agri-environmental activity. Non-increasers were, overall, consistently less diversified and active in farm management than other groups. However, it is important to note that the defined 'past increasers' also shared some of the characteristics of the 'future increasers', suggesting that there are limits to how much afforestation can occur on these enterprises. These saturation levels may require further investigation.

6. Conclusion and recommendations

In this paper, we summarised farmer attitudes to woodland expansion using a combination of recent farm woodland change and intended future behaviour. We have compared groups of farmers with similar attitudes, and advanced knowledge of farmer decision-making by considering associations between intentions to expand forestry and other forms of farm diversification. Developing this understanding is essential, given the wider context of recent falls in agricultural income in Scotland (Scottish Government, 2016) and the necessity of farm adaptation to remain viable (described by Convery et al., 2012: 298). We argue that farmers who are already engaged in woodland and/or other types of non-agricultural activities, who are well educated and/or are relatively new entrants to farming, should form an important target population for efforts to encourage woodland expansion.

The significant associations between intentions to expand forestry and other forms of farm diversification could indicate a route to encouraging woodland expansion among farmers. It is recognised that

different forms of farm diversification are correlated (Khanal and Mishra, 2015). Findings in this paper suggest that diversified farmers, particularly those with histories of participating in agri-environmental schemes, renewable energy, tourism and organic farming should be targeted for efforts to increase woodland and renewable energy production. It has been noted that woodland expansion for carbon storage could be encouraged if it provides diverse benefits to rural areas (Nijnik et al., 2013); multifunctional forestry is a principle of the EU Forest Strategy, which also recognises the economic and diversification potential of wood biomass and products (European Commission, 2013).

Our research would support a policy approach which repackages forestry as an activity that complements and benefits farming, possibly through smaller areas of woodland (Wynne-Jones, 2013; Schirmer and Bull, 2014); more focused (rather than extensive) tree planting for carbon sequestration has been recommended elsewhere (Nijnik et al., 2013). Small woodlands would correspond with farmer decision-making patterns, which usually consider smaller sub-areas of the farm rather than the whole (Dandy, 2012; Valatin et al., 2016). Similarly, the recommendation by Burton (2004) to enable woodland planting in ways which are sympathetic to farming culture "…by allowing some structure or neatness to their construction, to at least get woodland management reintegrated within farmer's notion of 'farming roles'" (ibid: 212) would clearly be beneficial.

While farmers' negative views of forestry have been commonly recorded, generalisations of farmer attitudes may form an oversimplification, and underestimate the potential for smaller-scale tree planting (Dandy, 2012). Indeed, evidence from Scottish grant applications suggests that farmers consider a range of objectives for woodland, including landscape, wildlife and activity benefits (Nijnik and Mather, 2008), correlating with the observation that farmers are "…often including small pockets of woodland seen as delivering desirable non-market benefits" (Valatin et al., 2016: 32). It is possible that local demonstration woodlands could be a useful approach, as these have been recommended in the context of biomass (Wood Fuel Task Force, 2008; Convery et al., 2012) and as a 'policy nudge' to encourage woodland expansion (Valatin et al., 2016). In summary, the uptake of small-scale tree planting by 'non-increasers' and the traditional farming community should be carefully encouraged.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.forpol.2017.01.014.

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